Remarks

Reconsideration of this Application is respectfully requested.

Claims 14-37 are pending in the application, with claims 14 and 29 being the independent claims.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "**Version with markings to show changes made**."

Based on the above Amendment and the following Remarks, Applicants respectfully request that the Examiner reconsider all outstanding objections and rejections and that they be withdrawn.

Submitted herewith is a Request for Drawing Change Approval to address the objections to the drawings noted in the Action. Specifically, in response to items 1 and 2 of the Action, the legend "State of the Art" has been replaced with --Prior Art-- in Fig. 1 and the legend "Invention" has been removed from Fig. 2. In response to item 4 of the Action, Figs. 11(a) and 11(b) have been renumbered Figs. 10(a) and 10(b). In response to the item 6 of the Action, schematic representations have been added to Fig. 10(b) to represent a Wollaston prism, a retarding plate of a Glan-Thomson prism, filters, and a position-resolving photo diode. It is respectfully noted that a grid (H) and a polarizing beam splitter (St1 - St3) are shown in Fig. 10(a). In response to item 5 of the Action, it is respectfully noted that Figs. 2 and 5 are labeled with reference numerals.

In response to the objection to the specification in items 7, 8, 9 and 10 of the Action, an abstract to the disclosure, a brief description of the drawings section, section headings, and a

description of Figs. 8 and 9 have been added to the specification. Further, references to Fig. 11 have been amended to refer to Fig. 10. In response to the statement in item 10 that the specification does not refer to each reference number in each figure, it is respectfully pointed out that there is no requirement that each reference number be described with respect to *each* figure. Each reference number shown in the figures is described in the specification, albeit not with respect to each separate feature. However, to alleviate any confusion, a statement has been added to the specification which states that commonly referenced features also refer to similar features throughout all of the drawings. The specification has also been amended to correct the informalities noted by the Action in item 11. In response to item 12, the specification has been amended to provide proper antecedent basis to a Wollaston prism, a retarding plate of a Glan-Thomson prism, filters, and a position-resolving diode. It is respectfully noted that the table in on page 10-11 of the specification provides antecedent basis to a grid and a polarizing beam splitter.

The claims have been amended to overcome the claim objections noted in items 13-16 and the claim rejections under 35 U.S.C. §112, second paragraph, in item 17.

Claims 14, 15 and 19-23 stand rejected under 35 U.S.C. §102(e) as being anticipated by Marxer et al.

Marxer et al. teaches a measuring sytem wherein a light beam is directed toward a surface of an object to be examined along a direction normal to the surface. The surface of the object is moved such that the stationary beam of the system scans the surface along a spiral path. An ellipsoidal mirror is placed with its axis along the surface normal to collect light scattered in different angles by the surface and any anomalies at the surface at collection angles away from

the surface normal. The ellipsoidal mirror reflects and focuses light that is rotationally symmetric about said axis of symmetry and that passes through the input aperture.

In contrast to the present invention, the assembly taught in Marxer et al. is not able to measure the dimensions of an object, but only to inspect surfaces, in particular, the detection of small particles and defects on wafers. (see page 1, lines 15-21) Marxer fails to teach "an emitter unit…which define a scanning beam path and a scanning plane", as recited in independent claim 14. Because Marxer et al. has a stationary laser, it cannot teach an emitter unit which defines a scanning plane. Accordingly, claims 14 distinguishes over Marxer et al. and is allowable. Claims 15 and 19-23 are dependent from claim 14 and are allowable as being dependent from an allowable claim.

Claims 16-18 and 25-27 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Marxer et al. in view of Musto et al. Claims 16-18 and 25-27 are each ultimately dependent from claim 14. It is noted that Musto et al. fails to cure the deficiency in the rejection of claim 14, discussed above. Claims 16-18 and 25-27 are allowable as being dependent from an allowable claim.

Claim 24 stands rejected under 35 U.S.C. §103(a) as being unpatentable over Marxer et al. Claim 24 is ultimately dependent from claim 14. Claim 24 is allowable as being dependent from an allowable claim.

Claims 29, 30 and 34-37 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Marxer et al. in view of Kleinknecht et al. As in the rejection of claim 14, Marxer et al. and Kleinknecht fail to teach "an emitter unit…which define a scanning beam path and a scanning plane", as recited in independent claim 29. Accordingly, claim 29 distinguishes over the cited

prior art. Claims 30 and 34-37 are each ultimately dependent from claim 29. Claims 30 and 34-37 are allowable as being dependent from an allowable claim.

Claims 31-33 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Marxer et al. in view of Kleinknecht et al. and Musto et al. It is noted that Musto et al. and Kleinknecht et al. fail to cure the deficiency in the rejection of claim 29, discussed above. Claims 31-33 are each ultimately dependent from claim 29. Claims 31-33 are allowable as being dependent from an allowable claim.

Conclusion

All of the stated grounds of objection and rejection have been properly traversed, accommodated, or rendered moot. Applicants therefore respectfully request that the Examiner reconsider all presently outstanding objections and rejections and that they be withdrawn. Applicants believe that a full and complete reply has been made to the outstanding Office Action and, as such, the present application is in condition for allowance with claims 14-37.

If the Examiner believes, for any reason, that personal communication will expedite prosecution of this application, the Examiner is hereby invited to telephone the undersigned at the number provided.

Prompt and favorable consideration of this Amendment is respectfully requested.

Respectfully submitted,

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Version With Markings To Show Changes Made

In The Specification:

Please amend the specification as follows:

Page 1, replace the heading beginning on line 1 with the following rewritten heading:

[Description] Background of the Invention

Page 1, delete the heading beginning on line 6 as follows:

[Prior Art]

Page 1, replace the paragraph beginning on line 7 with the following rewritten paragraph:

For measuring bodies accessible from both sides, telecentric laser scanners have been used [multiply]. Fig. 1 illustrates the principle of these scanners. The scanner unit (1) emits a laser beam (2) directed onto the opposite receiver unit (4). When an object to be measured (3) is not placed into the beam path the beam path will arrive in the receiver without being influenced, and is detected there with a photo diode (6) disposed in the focal point of the optical system of the receiver (5). When the beam hits an object to be measured, it is vignetted. For measuring, the laser beam is shifted in parallel with the line interconnecting the scanner and the receiver at a constant rate (scanning rate v_S). When the scanning rate is known it is possible to calculate the size of the object to be measured along a direction normal on the shifting direction by derivation from the beam vignetting period.

Page 1, replace the paragraph beginning on line 26 with the following rewritten paragraph:

In other scanning concepts, a specific diaphragm and two photo diodes are used, instead of one photo diode in the focal plane of the optical receiving system (EP 0 439 803). This concept permits the measurement of the shadow cast by objects having an extension smaller than the beam diameter of the laser beam. To this end, the Fraunhofer diffraction pattern is [analysed] <u>analyzed</u> when the laser beam is directed precisely onto the object to be measured. This point of time is [characterised] <u>characterized</u> by the fact that [then] the sum of both intensities is [t] <u>at</u> a maximum. The size of the object to be measured is then determined by derivation from the ratio of the intensities measured by [means of] the individual photo diodes by that point of time.

Page 2, replace the heading beginning on line 6 with the following rewritten heading:

[Problems] <u>Brief Summary of the Invention</u>

Page 2, replace the paragraph beginning on line 20 with the following rewritten paragraph:

The problem underlying the invention [consists in] <u>includes</u> the improvement of the laser scanner measuring system in such a way that it will be suitable for measuring objects accessible from one side and/or having complex shapes or structures. In accordance with the invention, this is achieved by the laser scanner measuring system [in correspondence with Claim 1] <u>disclosed herein</u>. Expedient embodiments of the measuring system are [characterised in the dependent claims] <u>also disclosed herein</u>.

Page 2 insert the following heading and paragraph between lines 25 and 26 as follows:

<u>Brief Explanation of the Drawings</u>

Fig. 1 is an example showing the known principle of a telecentric laser scanner;

Figs. 2a-d show examples of laser scanner measuring systems according to the present invention with different retro reflectors;

Fig. 3 shows an example of a laser scanner measuring system according to the present invention including a dark stop;

Fig. 4 shows a further example of a laser scanner measuring system according to the present invention including a dark stop;

Fig. 5 shows a further example of a laser scanner measuring system according to the present invention including a dark stop;

Fig. 6 shows a further example of a laser scanner measuring system according to the present invention including a dark stop;

Fig. 7 shows an example of a laser scanner measuring system according to the present invention having several (additional) retro reflector units on different positions relative to an object;

Fig. 8 shows an example of a laser scanner measuring system according to the present invention, wherein the laser beam is split by optical means in a direction orthogonal on the scanning plane and wherein a separate receiver is provided for each scanning line;

Fig. 9a/b show two examples wherein a laser scanner measuring system according to the present invention is built as a modular system; and

Figs. 10a/b show different elements for use in a modular system according to Figs. 9a/b.

Page 2, replace the heading at line 26 with the following rewritten heading

[The Invention] Detailed Description of the Invention

Page 2, replace the paragraph beginning on line 27 with the following rewritten paragraph:

The subject matter of the invention is a laser scanner measuring system for measuring objects accessible from one side and/or having complex shapes or structures[, which is adapted to be configured]. In the following description, common reference numerals described herein also refer to similarly numbered features throughout the drawings.

Page 3, replace the paragraph beginning on line 1 with the following rewritten paragraph:

The measurement from one side is achieved by [means of] a laser scanner measuring system which [consists] includes, for instance, [of] a combined illuminating/receiving unit (cf. item 8 in Fig.

2). The laser beam, which is emitted from the laser 12, passes through the beam splitter 11 and arrives, via the deflector unit 10 and the combined optical emitter/receiving unit 13, in the outside space. When the laser beam hits on a reflecting surface element of the object to be measured, which has a surface normal coinciding with the direction of the laser beam, the laser beam is reflected back into the receiver unit. It arrives, via the optical system, the deflector unit and the beam splitter, on the detector 6. It is then possible to derive the position of this surface element with an orientation orthogonal on the laser beam from the measurement of the point of time by which the laser beam is reflected back. In this manner it is possible, for example, to determine the [centre] <u>center</u> of a polished or glossy rod having a circular cross-section.

Page 3, replace the paragraph beginning on line 16 with the following rewritten paragraph:

When the laser beam scans over an object surface having scattering properties varying in the measuring field, the extension of zones having a distinctly different scattering characteristic can be measured. When the object has a dull surface in the solid state and a glossy surface in the liquid state, for instance, it is possible to determine the size of the liquid zone from the development of intensity versus time.

Pages 3, replace the paragraph beginning on line 25 with the following rewritten paragraph:

When a retro-reflecting unit can be arranged behind the object to be measured, when seen in the direction of emission (e. g. a retro-reflecting sheet 9a, mirrored cuboid corner 9b or a "lens-type" retro reflector), it is possible to measure further properties of the object. The retro reflector unit reflects the impinging beams along their own extension or in the direction orthogonal on the scanning plane (defined by the optical axis of the laser scanner and the

direction of movement of the laser beam) back into the scanner receiving unit with an offset. With special configurations or arrangements of the retro reflector, specific types of measurement can be implemented. The following particularly excellent embodiments should be mentioned here as examples.

Page 4, replace the paragraph beginning on line 21 with the following rewritten paragraph:

This technique of evaluation makes use of the diffraction of the limiting rays on the object edges. It is only slightly influenced by variations of the laser output and a variation of the intensity of the laser radiation in the course of the scanning operation. It can be realised with both a laser scanner with separate emitter and receiver units (cf. Fig. 3) and laser scanners comprising a joint emitter/receiver unit (cf. Fig. 4). In the latter case, it may be expedient to dispose an additional lens 16 ahead of the dark field stop.

Page 4, replace the paragraph beginning on line 27 with the following rewritten paragraph:

When telecentric laser scanners in correspondence with prior art are used to measure glass tubes, malfunctioning may occur because there are three additional excellent beam paths, apart from the shade edges on the outside diameter, along which light arrives from the scanner unit in the receiver:

Page 5, replace the paragraph beginning on line 9 with the following rewritten paragraph:

The amplitudes of these signals is low in arrays in correspondence with prior art and yet they [re] <u>are</u> suitable to interfere with measurement. One of the inventive arrays leads to the effect that the reflections on the inner wall provide very well detectable signals with a high signal-to-noise ratio from which the wall thickness of the tubes can be calculated. These signals are appropriate for very

good analysis by determining those points of time by means of the electronic [analysing] analyzing system by which the signal reaches local maximum levels. One method to this end consists in a verification of the following conditions by means of the electronic [analysing] analyzing system:

Pages 5, replace the paragraph beginning on line 22 with the following rewritten paragraph:

Interference may occur with this type of evaluation of the edges and the reflection when the measurement must be performed in a dust-loaded environment or in an environment presenting strong movements or turbulences of the air. In these cases a system can be employed to achieve a substantial increase of the robustness of the measurement. To this end, the receiver beam path is split by means of a beam splitter 17 (cf. Fig 5 and Fig. 6) in such a way that one part of the radiation arrives on a photo diode with a dark field stop ahead of it, while another part of the radiation arrives directly on a second photo diode. The edges can be detected in the aforedescribed manner. The intensity measurement, which is additionally provided, issued to ensure that only signal maximums in the zone between the shadow edges will be used for evaluation. Interference caused by striation in the air or by dust in the zone outside the shadow edges are eliminated by inhibiting the evaluation as long or as [or] soon as the signal on the second photo diode exceeds a threshold (which can be set if necessary).

Page 6, replace the paragraph beginning on line 18 with the following rewritten paragraph:

A position-sensitive photo diode moreover permits the simultaneous detection of the reflection on the object surface and of the tilting angle of the object relative to the scanning plane. To this end, it is incorporated as a sensor in a receiver which is arranged at an angle different from 0° or 180° relative to the optical axis of the scanner.

Page 6, replace the paragraph beginning on line 23 with the following rewritten paragraph:

When two receivers are arranged on opposite sides of the object to be measured, at an angle relative to the scanning direction, it is possible to measure objects to be measured which have an extension wider than the width of the scanned zone. When the receivers are arranged, for instance, at angle of ± 90° relative to the beam direction, a reduction by a factor of 2^{05} is achieved for objects having a circular cross-section. This means that objects having an extension of up to 1.4 times that of the scanned zone can still be measured.

Page 6, replace the paragraph beginning on line 23 with the following rewritten paragraph:

As shown in Fig. 8, further [Further] geometric characteristics of the object to be measured are accessible to measurement if the laser beam is split by optical means 18 (such as a grid disposed in parallel with the scanning direction) in a direction orthogonal on the scanning plane. When separate receivers 4 are used, a separate receiver is provided for each scanning line. When a combined scanner/receiver unit is used, a grid is arranged preferably ahead of the beam splitter for splitting between the paths of the emitted and received beams, and splitting is performed by means of the grid. Then one respective photo diode or an element of a photo diode array is disposed in the path of the received beam in the focal point of the optical system per beam path to be evaluated. Due to the splitting of the scanning beam path into several partial beam paths, it is possible to determine the development of the object geometry along the plane orthogonal to the scanning plane. With this provision, it is possible, for instance, to detect reliably a conical extension of the object contour or a curvature of the object to be measured.

Page 8, replace the paragraph beginning on line 22 with the following rewritten paragraph:

For birefringent or optically active sheets it is possible, for instance, to determine the length of the optical path and thus the thickness of the layer or the ability of rotation towards the optical axis. To this end a scanner with a circularly polarised laser beam is used, together with a polarising beam splitter in the emitter or receiver beam path, and for each [for each] partial beam path a photo detector (element) is disposed.

Pages 8, replace the paragraph beginning on line 30 with the following rewritten paragraph:

When, in addition to this splitting, one or several filters are inserted into the receiver beam path, which are selective in terms of wavelength, it is possible to measure the following parameters for substances (such as PET) displaying an intrinsic polarised flourescence:

Page 9, replace the paragraph beginning on line 6 with the following rewritten paragraph:

In the case of PET, the intrinsic polarised fluorescence occurs selectively in the non-crystalline zones. These are decisive for the mechanical properties and for the receptivity for dyes of the object. Via a measurement of the momentums of the orientation distribution function, it is possible to use the aforedescribed system for a selective detection of the development and gradient of these parameters in the material.

Page 9, replace the paragraph beginning on line 11 with the following rewritten paragraph:

Further characteristic parameters of the object to be measured can be detected if two beam paths (the beam path coming from the object and a (possibly modulated) reference beam path or a second beam path passing through the object space or coming from the object) are superimposed in

the receiver unit in such a way that the beams will interfere with each other. Depending on the configuration of this beam path and the signal analysis it is then possible, in addition to the detection of the aforedescribed characteristic parameters, to detect the spacing or the contour of an object to be measured along the direction of the optical axis, or to detect the velocity of the movement of the object to be measured through the scanning plane. When the retro reflector principle is applied it is possible to establish the reference beam path in the form of a Michelson interferometer, for instance, inside the combined emitter/receiver unit. In the event of application of a separate receiver unit, the reference beam path (passing by the object to be measured) can be guided through the object space or by means of optical guides from the scanner to the receiver.

Page 9, replace the paragraph beginning on line 11 with the following rewritten paragraph:

The aforementioned types of measurement may be combined with each other [almost] optionally. This can be [realised] <u>realized</u> in a particularly expedient manner when a modular system is provided which [consists of] <u>includes</u> a scanner head, a measuring module and possibly a receiver housing with the optical system. <u>As shown in Fig. 9, the</u> [The] scanner unit 1 <u>includes</u> [consists of] a laser (12), a deflector unit (10), and an optical system 19, as wells as the following additional components, if necessary (when the reflection or retro scattering is measured or when a retro reflector unit is employed): receiver module (20) <u>and</u> scan start and scan stop reflector (14).

Page 10, replace the paragraph beginning on line 6 with the following rewritten paragraph:

The receiver module is provided with means for mounting detector modules thereon (cf. the schematic illustration in Fig. [11] <u>10</u>b), lenses or mirrors (items A to H in Fig. [11] <u>10</u>a) and beam

splitters (cf. items St1 to St3 in Fig. [11] 10a). Alternatively, a position-resolving photo diode D5, a filter D6, a Wollaston prism D7 and a retarding plate of a Glan-Thomson prism D8 can be used in the present invention. Depending on the equipment of the receiver module and the selected arrangement various measured parameters can be derived. Some examples thereof are listed in Table 1:

In the Claims:

Please amend the claims as follows:

14. (Amended) A laser scanner measuring system for measuring an object comprising:

an emitter unit having a laser, a beam deflector unit and an optical emitter system which define a scanning beam path [as well as] and a scanning plane;

a receiver unit including a photo detector disposed in the focal plane of an optical receiver system for a receiver beam path, wherein the surface normal of said optical receiver system is parallel with the scanning beam path;

a dark field stop disposed ahead of said photo detector in the receiver beam path in the focal plane of said optical receiver system; and

a beam splitter ahead of said dark field stop for splitting a partial beam from the receiver beam path, [; and] said photo detector including a photo diode arranged in said partial beam, said photo diode being disposed approximately in the focal point of said optical receiver system.

15. (Amended) A laser scanner measuring system according to Claim 14, wherein said emitter unit and said receiver unit are disposed on the same side relative to [an] the object to be measured.

17. (Amended) A laser scanner measuring system according to Claim 14, further comprising at least one retro reflector or a retro-reflecting marker disposed inside said emitter unit [in a zone between said beam deflector unit and a beam-emerging site].

18. (Amended) A laser scanner measuring system according to Claim 14, further comprising <u>additional</u> [one or several] receiver units or retro reflectors [are] disposed at an angle different from 0° or 180° relative to [the] <u>an</u> optical axis of the scanner unit in the scanning plane.

20. (Amended) A laser [scanning] <u>scanner</u> measuring system according to Claim 19, wherein there is formed a grid having lines oriented orthogonally with respect to the scanning direction.

22. (Amended) A laser [scanning] <u>scanner</u> measuring system according to Claim 21, where there is formed a grid having lines oriented parallel with respect to the scanning direction.

23. (Amended) A laser scanner measuring system according to Claim 14, further comprising optical elements disposed in the [illuminating] <u>scanning</u> beam path and/or the receiver beam path for radiation of different polarisation.

24. (Amended) A laser [scanning] <u>scanner</u> measuring system according to Claim 23,

wherein said optical elements [are] comprise at least one of a polarising beam splitter, a Wollaston prism, and a retarding plate of a Glan-Thomson prism.

25. (Amended) A laser scanner measuring system according to Claim 14, [wherein] further comprising filters selective in terms of wavelength disposed in the receiver beam path.

26. (Amended) A laser [scanning] scanner measuring system according to Claim 25, wherein said filters are interference filters, color filters or cut-off filters.

27. (Amended) A laser scanner measuring system according to Claim 14, wherein said emitter unit and said receiver unit from a single combination unit and wherein a reference beam path is realised in the [combined scanner/receiver] combination unit, in the outside space or by means of a light guide, which is superimposed by the beam path coming from the object to be measured in such a way that the resulting interference pattern which varies locally and in the course of time is detected by means of at least one detector element.

28. (Amended) A laser scanner measuring system according to Claim 14 [for application for], wherein said measuring system is adapted to control [of] a production process.

29. (Amended) A laser scanner measuring system for measuring an object comprising an emitter unit having a laser, a beam deflector unit and an optical emitter system, which define a scanning beam path as well as a scanning plane; and a receiver unit including a photo detector

disposed in the focal plane of an optical receiver system for a receiver beam path, the surface normal of said optical receiver system being parallel with the scanning beam path, and said photo detector being a photo diode array or a position-resolving photo diode.

32. (Amended) A laser scanner measuring system according to Claim 29, further comprising at least one retro reflector or a retro-reflecting marker disposed inside said emitter unit [in a zone between said beam deflector unit and a beam-emerging site].

33. (Amended) A laser scanner measuring system according to Claim 29, further comprising [one or several] <u>additional</u> receiver units or retro reflectors disposed at an angle different from 0° or 180° relative to [the] <u>an</u> optical axis of the scanner unit in the scanning plane.

35. (Amended) A laser [scanning] <u>scanner</u> measuring system according to Claim 34, wherein there is formed a grid having lines oriented orthogonally with respect to the scanning direction.

37. (Amended) A laser [scanning] <u>scanning</u> measuring system according to Claim 36, where there is formed a grid having lines oriented parallel with respect to the scanning direction.

Abstract of the Disclosure

A laser scanner measuring system for measuring an object is provided. An emitter unit has a laser, a beam deflector unit and an optical emitter system which define a scanning beam path and a scanning plane. A receiver unit includes a photo detector disposed in the focal plane of an optical receiver system for a receiver beam path. The surface normal of the optical receiver system is parallel with the scanning beam path. A dark field stop is disposed ahead of the photo detector in the receiver beam path in the focal plane of said optical receiver system. A beam splitter is ahead of the dark field stop for splitting a partial beam from the receiver beam path. The photo detector includes a photo diode arranged in said partial beam, approximately in the focal point of the optical receiver system.